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Development, maintenance and application of the United Nations Framework Classification for Resources: Petroleum

Case study on bridging from the Oil and Fuel Gas Reserves and Resources Classification of the Russian Federation to the United Nations Framework Classification: Field A in West Siberia, Russian Federation

Prepared by the Petroleum Working Group of the Expert Group on Resource Classification

Summary

This case study explains how estimated quantities of petroleum resources for a discovery under further evaluation, which have been classified under the Oil and Fuel Gas Reserves and Resources Classification of the Russian Federation, can be reported according to the United Nations Framework Classification for Resources (UNFC) by use of the new guidance contained in the Bridging Document between the Oil and Fuel Gas Reserves and Resources Classification of the Russian Federation of 2013 and UNFC of 2009.

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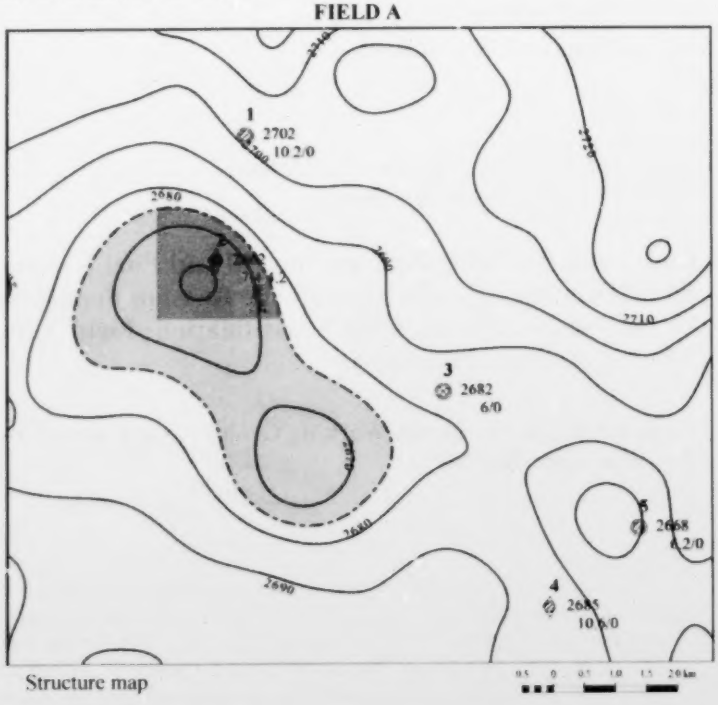
I. Introduction

1. This case study was prepared by Jan Bygdevoll, Steve Griffiths, Dominique Salacz and Alexander Shpilman (lead author) based on information provided from an undeveloped oil discovery in West Siberia, referred to here as "Field A".

2. Four wells have been drilled on the Field A structure; one discovered and tested oil ("Well #2"), while the three other wells ("Well #1", "Well #3" and "Well #4") are in the water zone. The discovery is situated in Jurassic sediments (J3), with lithology well known in the area. A top structure depth map, based on interpretation of 2D seismic data and information from the wells, had been constructed (see Figure 1).

Figure 1
Top structure depth map of discovery



Structure map

LEGEND

	Exploration wells with water inflow
	Wildcat wells with water inflow
	Exploration water-yielding wells by well log data
	Wildcat wells with oil inflow
	Reservoir top contour
	Outer oil pool outline
	C1 reserves area
	C2 reserves area
1	Well number
2685	Reservoir top absolute depth
10 6/0.00	Effective thickness/Net oil thickness

3. The discovery is considered to be one single pool (deposit), but the right to utilize the licence plot has not yet been transferred to an oil company. Field A is therefore situated in the unlicensed territory ("resources in open area") and is considered to be a "field under exploration", which means that a production licence has not yet been issued, and a project design document has not yet been made (reference the Bridging Document between the Oil and Fuel Gas Reserves and Resources Classification of the Russian Federation of 2013 (RF2013) and the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009)[1] (Bridging Document[2]) paragraph 6).

II. Description of the project

4. Based on information available at the time of preparing this case study, volumetric calculations had been made separately for two parts of the deposit; one for the area of the oil zone closest to the discovery well (Area 1) and one for the more distal part of the hydrocarbon bearing structure (Area 2).

5. The parameters used in the calculation of oil (and gas) volumes, such as net pay, porosity, oil saturation, oil properties etc. were based on well logs and tests from the discovery well and the nearby wells lower on the structure in the water zone.

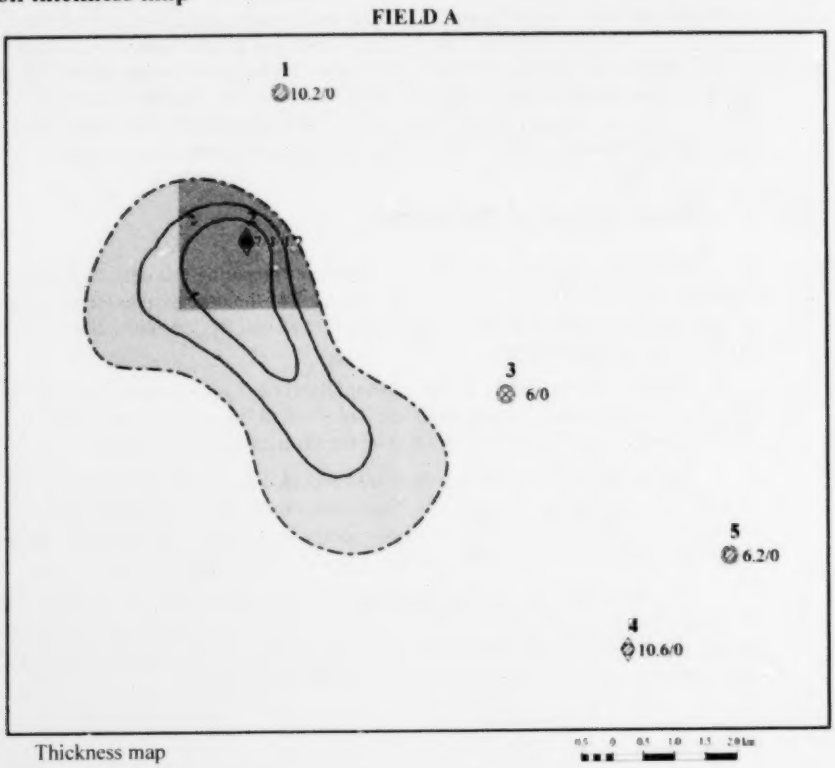
6. The formation test of the discovery well provided an inflow of 9 tonnes per day (tpd) of clean oil (no water) and, since it had not been directly observed in any of the wells, a common oil-water contact (OWC) had been nominally defined and assigned to the base of the lowest tested interval in Well #2, at 2,676 m true vertical depth (TVD).

7. Data from the discovery well indicated a net pay thickness of 4.2 metres. Test data from other wells (e.g., Well #1 and Well #4) confirmed the reservoir quality in a wider area around the discovery well. In addition to the top structure depth map, a net pay thickness map was constructed for the volumetric calculations (see Figure 2).

[1] The United Nations Framework Classification for Resources (UNFC) changed its name in April 2017. Prior to this, UNFC was known as the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009).

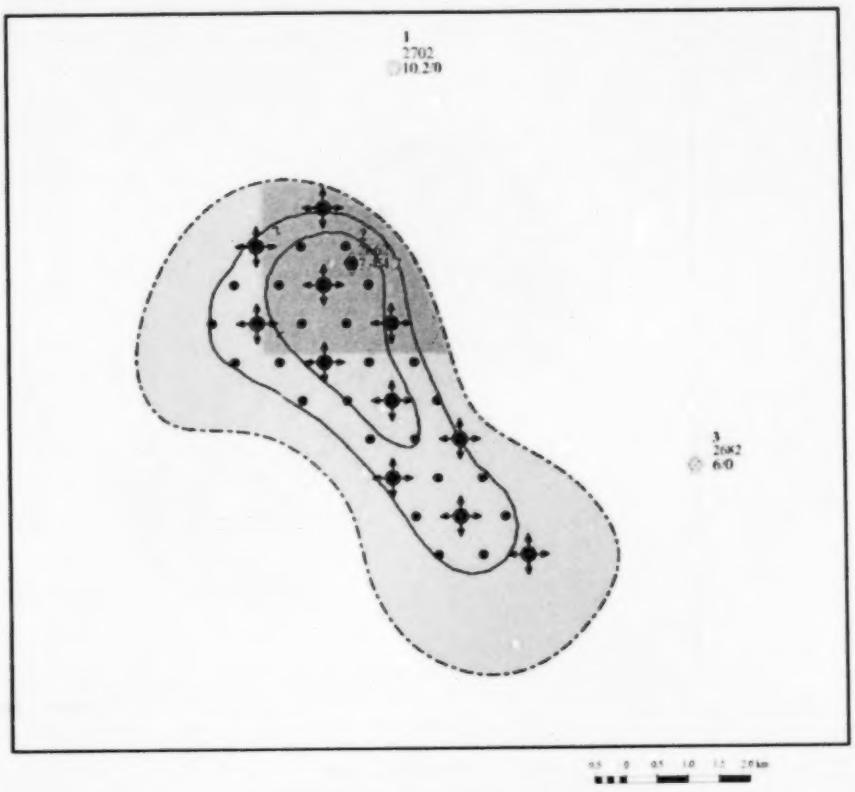
[2] Available in English and Russian on the United Nations Economic Commission for Europe (ECE) website at: http://www.unece.org/sed/unfc/rf2013bd.html

Figure 2
Net oil thickness map



8. For the calculation of recoverable quantities, an oil recovery factor of 0.3 was applied for both areas of the deposit, based on data from analogous nearby oil field developments and a nominal 500 m spacing waterflood pattern development scheme such as that illustrated in Figure 3.

Figure 3
Potential future field development schemes, with either vertical or horizontal wells



LEGEND

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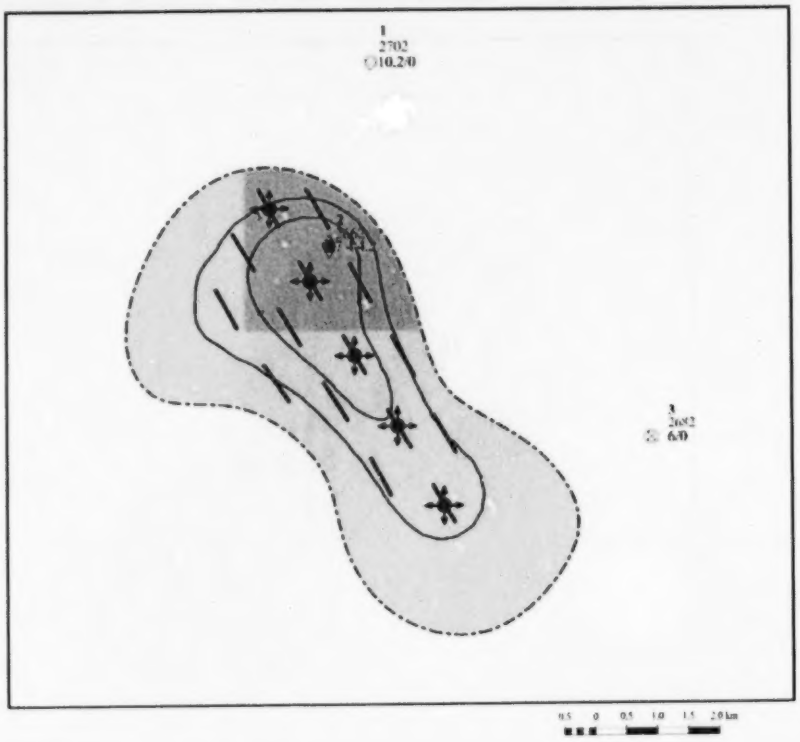
- C1 reserves area
- C2 reserves area
- 1 — Well number
- 2685 — Reservoir top absolute depth
- 10.6/0.30 — Effective thickness/Net oil thickness



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9. According to the information provided on regional infrastructure in the area around Field A, it was noted that the closest producing oil field is situated 15 km away, and the distance to the closest regional hard-top road is 18 km. The nearest oil-trunk pipeline in the area is 140 km away, and there is an inter-field oil pipeline 18 km from the discovery.

10. No information was available regarding why an exploration and production licence for Field A had yet to be issued, or on the likelihood of one being issued in the foreseeable

future. However, it was noted that the reported Well #2 test flow rate was above the minimum of 5 tpd that is generally deemed to be commercial and cost-effective at analogous developments in the area.

11. Given the historical track record of oil fields being commercialized nearby, for the purposes of this case study, it was therefore assumed that future development of Field A can be considered to be technically feasible and that its associated gas sales volumes could also be commercialized.

12. A summary of the average reservoir property parameters and the calculated RF2013 volumetric and ultimate recovery estimates for each of the two areas of Field A is shown in Table 1.

Table 1
Overview of reservoir parameters and calculated volumes according to RF2013

	Category		*Category*	
Area No	**1**		**2**	
Zone	**Pay zone with exploration well**		**Pay zone without exploration well**	
Oil productive area, 1,000 m^2	3,149		11,708	
Average oil net pay, m	3.86		2.39	
Net oil productive volume, 1,000 m^3	12,150		27,984	
Effective porosity, fraction	0.17		0.17	
Oil saturation factor, fraction	0.54		0.54	
Shrinkage factor, fraction	0.9		0.9	
Oil density, t/m^3	0.86		0.86	
Oil recovery factor, fraction	0.3		0.3	
Initial oil reserves in place, 1,000 t	863		1,988	
Additional quantities of oil in place	**604**	**C1****	**1,392**	**C2****
Initial oil reserves recoverable 1,000 t	259		596	
Cumulative oil production, 1,000 t	0		0	
Remaining oil reserves in place, 1,000 t	863		1,988	
Remaining oil reserves recoverable, 1,000 t	**259**	**C1**	**596**	**C2**
Gas factor (GOR), m^3/t	50		50	
Initial gas reserves in place, GSm^3	43		99	
Additional quantities of gas in place, GSm^3	**30**	**C1****	**69**	**C2****
Initial gas reserves recoverable, GSm^3	13		30	
Cumulative gas production, Gsm^3	0		0	
Remaining gas reserves in place, GSm^3	43		99	
Remaining gas reserves recoverable, GSm^3	**13**	**C1**	**30**	**C2**

III. Resource classification

A. Oil and Fuel Gas Reserves and Resources Classification of the Russian Federation

13. According to the Oil and Fuel Gas Reserves and Resources Classification of the Russian Federation of 2013 (RF2013), for projects still under evaluation, and having a similar commercial development status and level of geological knowledge as Field A, volumes are calculated separately for the area of the field including the discovery well and for the more remote area of the deposit with less well control.

14. According to RF2013, for Field A the recoverable oil volume calculated in Area 1 ($259*10^3$ tonnes) is classified as Category C1 reserves, and the recoverable oil volume calculated in Area 2 ($596*10^3$ tonnes) is classified as Category C2 reserves.

15. The oil volume in place calculated in Area 1 ($863*10^3$ tonnes) is also classified as Category C1 reserves, and the oil volume in place calculated in Area 2 ($1,988*10^3$ tonnes) is similarly classified as Category C2 reserves.

16. In addition, on the assumption that the processed associated gas from Field A will be sold (i.e. not used for fuel, or flared), the recoverable gas volume calculated in Area 1 (13 GSm^3) is classified as C1 and the recoverable gas volume calculated in Area 2 (30 GSm^3) is classified as C2.

17. Additional quantities in place are not classified in RF2013, but can be calculated by subtraction of recoverable reserves from in-place reserves, and are designated C1** and C2** in accordance with the Bridging Document.

B. Bridging to UNFC

18. In this case study, for the purposes of bridging to UNFC, the future development of Field A will be considered to be one project. Although several alternative project scenarios can also be envisaged (e.g., a further appraisal project for Area 2, a pilot project for Area 1, phased or incremental field development projects, etc.), since there has so far been one exploration project for the whole structure, it has been assumed that there also will be one future project for the development of the deposit.

IV. Mapping E and F axes

19. When mapping to the E and F axes of the United Nations Framework Classification for Resources (UNFC), the quantities belonging to C1 and C2 categories of RF2013 may correspond to any of the Codes 4, 5, 6 or 7 in Table 3 of the Bridging Document (see Tables 2 and 3).

20. This means that the RF2013 C1 and C2 Categories do not specify very precisely which E and F axes categories/sub-categories should be used. In principle, any of the mappings outlined in blue could potentially be applicable, which implies that information other than simply the C1 and C2 annotation must be used to classify along both the E and F axes.

Table 2
Number and Colours coding for mapping of RF2013 to the E-F Matrix of UNFC (from Bridging Document)

	F1.1	F1.2	F1.3	F2.1	F2.2	F2.3	F3.1	F3.2	F3.3	F4
E1.1	1	2	3	4						
E1.2	1	2	3							
E2			4	4	4					
E3.1	12	12	12	12	12	12				
E3.2			6	6	6		8	9	10	
E3.3			7	7	7	7				11

Table 3
Comparison of classes and Sub-classes in UNFC with RF2013 Categories (from Bridging Document)

Class	*Sub-class*	*Code*	*RF2013 Category*
Commercial Projects	On Production	1	A
	Approved for Development	2	B1
	Justified for Development	3	B2
Potentially Commercial Projects	Development Pending	4	A*, B1*, B2* C1, C2
	Development on Hold	5	A*, B1*, B2* C1, C2
Non-Commercial Projects	Development Unclarified	6	C1, C2
	Development Not Viable	7	C1, C2
Additional Quantities in Place		11	A**, B1**, B2** C1**, C2**
Exploration Projects	Prospect	8	D0
	Lead/High Risk Prospect	9	DL
	Play	10	D1, D2
Additional Quantities in Place		11	D0**, DL**,D1**, D2**
Produced Not Sold		12	

Note that Code 12 refers to quantities typically referred to as "fuel, flare and losses". Fuel is that portion of production consumed in operations and thus not delivered to the sales reference point.

A. E axis

21. Code 4 could potentially indicate either Category E1 (Sub-Category E1.1) or Category E2. Codes 4 or 5 could indicate Category E2. Codes 6 or 7 could indicate Category E3(Sub-Categories E3.2 and E3.3 respectively).

22. **E1** has the following definition:

- *Extraction and sale has been confirmed to be economically viable.*

And this supporting explanation:

- *Extraction and sale is economic on the basis of current market conditions and realistic assumptions of future market conditions. All necessary approvals/contracts have been confirmed or there are reasonable expectations that all such approvals/contracts will be obtained within a reasonable timeframe.*

23. **E2** has the following definition:

- *Extraction and sale is expected to become economically viable in the foreseeable future*

And this supporting explanation:

- *Extraction and sale has not yet been confirmed to be economic but, on the basis of realistic assumptions of future market conditions, there are reasonable prospects for economic extraction and sale in the foreseeable future.*

24. **E3.2** has the following definition:

- *Economic viability of extraction cannot yet be determined due to insufficient information (e.g. during the exploration phase).*

25. **E3.3** has the following definition:

- *On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic extraction and sale in the foreseeable future.*

26. The fact that the discovery is not in a licensed area and no owners have committed themselves to any development, precludes the use of Category E1 (and hence Sub-Category E1.1), since the timeframe for obtaining all necessary approvals/contracts is currently too uncertain.

27. Based on the data, analysis and interpretation provided regarding Field A, the information from analogous fields indicates that a future field development project could potentially be made economically and socially viable. This supports the assertion that the project should not be mapped as Code 7 (Sub-Category E3.3), and implies that the project currently falls into either E-axis Category E2 or Sub-Category E3.2.

28. While Category E2 would seem possible, to support this a company would have to be sufficiently confident of obtaining suitable licence terms for Field A and be able to demonstrate that it is currently reasonable to recognize the project as being economically viable under a feasible development plan. Alternatively, if it is considered that further information would be required in order to determine the economic viability of extraction, and/or project commerciality, then Sub-Category 3.2 would be indicated.

29. Given the absence of a licence (or any other formal rights for a party to continue the project), the Bridging Document suggests that the project should currently be placed in the maturity class "Non-Commercial Projects" as there is no commitment yet towards the development of Field A. The most appropriate Sub-class is "Development Unclarified"

(Code 6), which implies Sub-Category E3.2. This effectively rules out Codes 4 and 5 (and therefore Category E2), as both would require that a development plan had been defined. In Russia, the exploration stage is considered to be finished when C1 to C1+C2 reserves ratio is equal to or more than 80 per cent, but in the present case the C1 to C1+C2 ratio is about 30 per cent which means the exploration stage is ongoing. Consequently E3.2 is the preferred Sub-category.

30. It is recognized that E3.2 could potentially be viewed as being too conservative, in particular when referring to UNFC definitions. This is particularly the case if further context could confirm the way that analogous projects in the region have progressed from the exploration stage in the past, and it is then considered that it can reasonably be demonstrated that (despite there being no licence or current development plans), future development is likely to be economic. In which case, this could be a "Potentially Commercial Project (Pending or on Hold)" with Code 4 or 5, and Category E2 would be justified.

31. However, on balance it is considered that **E3.2** is the most appropriate UNFC E-axis Sub-Category at this stage, given the absence of some key information required to determine unambiguous criteria for evaluation of the resources and to determine the level of confidence in their economic extraction and sales in the foreseeable future.

B. F axis

32. Table 4 shows that Code 6 (E3.2) could potentially be bridged to the F-axis Sub-Categories F1.3, F2.1 or F2.2, dependent on project feasibility and status.

33. The project does not currently qualify for Category F1 (*confirmed development project*), but it does meet the minimum necessary conditions for Category F2.

34. If project activities are ongoing to justify development, the most favourable position along the F axis is the Sub-Category F2.1. However, the available information for Field A does not suggest that any such activities are ongoing. Therefore, the most suitable Sub-Category currently appears to be **F2.2** (*Project activities are on hold and/or where justification as a commercial development may be subject to significant delay*).

35. Taking the above-mentioned into consideration, the conclusion is that the reported RF2013 C1 and C2 hydrocarbon sales quantities for Field A in the project are classified as **E3.2, F2.2**.

36. In addition, the non-recoverable reserves presented in Table 1 as C1** and C2 **, are considered to be "additional quantities in place" for Field A (Code 11) and are classified as **E3.3, F4**.

Table 4
Number and Colour coding for mapping of RF2013 to the E-F Matrix of UNFC (from Bridging Document)

	F1.1	F1.2	F1.3	F2.1	F2.2	F2.3	F3.1	F3.2	F3.3	F4
E1.1	1	2	3	4						
E1.2	1	2	3							
E2			4	4						
E3.1	12	12	12	12	12	12				
E3.2			6	6	6		8	9	10	

V. Mapping the G axis

37. According to Figure 1 in the Bridging Document, regarding the G axis, the volume classified in RF2013 as C1 reserves should be classified as G1 under UNFC. This implies that the interpretation of the well data and seismic around the discovery well is appropriate for the calculation of volumes across the whole of Area 1, and fits the criteria; "*quantities associated with a known deposit that can be estimated with a high level of confidence*".

38. Also according to the Bridging Document, the volume classified as C2 reserves in RF2013, and pertaining to the whole of Area 2, is considered to have "*confidence levels ranging from moderate to low*", so should be categorized as G2 + G3 in UNFC. (It should be noted that the notations G1, G2 and G3 are being used in the discrete or incremental sense, not the cumulative sense)[3].

39. Due to the designated incremental mechanism for mapping of the RF2013 C1 and C2 reserves in the Bridging Document, it should be noted that it is not possible to report a central estimate of total reserves at the project level (i.e. covering the entire field area).

40. Based on the assumptions that the development of Field A is considered as one project and that only the processed oil could be sold, the UNFC resource volume estimates are as in Table 5).

Table 5
Cumulative values (oil volumes)

RF2013	*UNFC*	*Oil (1,000 tonnes)*
Recoverable	**E3.2, F2.2, G1**	**259**
Recoverable	**E3.2, F2.2, G2+G3**	**596**
Recoverable	**E3.2, F2.2, G1+G2+G3**	**855**
Non-recoverable	**E3.3, F4, G1+G2+G3**	**1,996**

41. There is currently no certainty that all volumes of associated petroleum gas will be sold. Depending on the details of the Field A development plan, the produced gas volumes might be (fully or partially) flared, used towards electricity production, or used directly as fuel, etc. Once the final development plan is approved, the portion of associated petroleum gas volumes that will be utilized, and how they will be utilized, will become clearer. Thus, the recoverable associated gas volumes should be mapped at this stage to Code 12. For this reason, the E-axis Category E3.1 has been applied to the RF2013 C1 and C2 gas reserves (Table 6).

Table 6
Cumulative values (gas volumes)

RF2013	*UNFC*	*Gas (GSm^3)*
Recoverable	**E3.1, F2.2, G1**	**13**

[3] Note that RF2013 provides best estimates and not the high (or low) cases.

RF2013	*UNFC*	*Gas (GSm^3)*
Recoverable	**E3.1, F2.2, G2+G3**	**30**
Recoverable	**E3.1, F2.2, G1+G2+G3**	**43**
Non-recoverable	**E3.3, F4, G1+G2+G3**	**99**

VI. Observations and discussion

A. Dataset observations

42. Although the goal of this case study is not to challenge the evaluation of reserves presented, a number of technical observations can be made. These are briefly summarized in the ensuing text.

43. Comprehensive information on the methodologies employed for calculation of the reservoir volumetric and recovery estimates were not available (e.g. no information was provided on the relationship between net and gross thickness). However, this was not considered important for the purpose of classification according to UNFC, although it should be noted that alternative interpretation and calculation methodologies could potentially affect the estimates of volumetrics and ultimate recovery.

44. The assumed field-wide OWC, based on the bottom of the tested interval in the discovery well, may be a conservative estimate.

45. The boundary between Area 1 and Area 2, in which the separate volumetric calculations were made, is assumed to be mainly based on the proximity to Well #2. While the map suggests that a saddle is present relatively close to the discovery well, potentially increasing the risks in the eastern part of the structure, the exact position of the boundary seems somewhat arbitrary.

46. Except for the net oil thickness, all the reservoir parameters and fluid properties, including the recovery factor, are estimated equal for the two areas in the calculations.

47. While the available data do not permit a specific probability level to be assigned to the average reservoir property values or the estimated reservoir volumes, except the OWC, the input parameters used in the volumetric calculations were understood to be based on best estimates.

48. The estimated recovery factor is reportedly based on data from analogous oil field development projects in similar physical and commercial circumstances. It is also resting on the assumption that a relevant number of production wells will be drilled in Field A.

49. Given the information that the average well spacing in this region of Russia is typically in the order of 500 m and wells are not usually drilled in the net pay thicknesses less than 2 m; it can be assumed around 34 vertical or 15 horizontal wells are needed for full development of this discovery, including the C2 area (5 km x 2.5 km) (Figure 3).

B. Classification observations

50. Since the RF2013 to UNFC Bridging Document leaves a wide range of possibilities for mapping resources in C1 and C2 to categories in UNFC, further information is needed (or has to be assumed) to select a specific mapping along the E and F axes.

51. It could be argued that if the parameters used to calculate the volumes are considered to be best estimates, the resulting volumes should, therefore, be classified as G1+G2 for each of the areas concerned. However, this would then be contrary to the incremental approach used as the basis for the Bridging Document mapping of C1 and C2 reserves to UNFC.

52. Due to the incremental approach used as the basis for mapping of the RF2013 C1 and C2 reserves in the Bridging Document, it is not easy to report a central estimate of the total Resource volumes at the full project level (i.e. covering the entire field area).

53. This case study can be extended to highlight some of the potential limitations associated with the workaround currently used for mapping of the G axis in UNFC. For example, it might take only one additional successful well to be drilled in the eastern area of the field, to then re-classify all the Area 2 volumes as C1 reserves. In which case the classification for Area 2 would evolve as follows (assuming, for the sake of simplicity, no changes were necessary to the current reservoir property parameters):

(a) Currently, Area 2 volumes are classified as E3.2, F2.2, G2+G3;

(b) 1 new well: Enables G3 → G1, giving E3.2, F2.2, G1 (which would still be Contingent Resources in the Petroleum Resources Management System (PRMS));

(c) Licensing and economics are then confirmed; Enables E3 → E1. This would then give E1, F2.2, G1 for the whole reservoir, with nowhere left to attribute G2 and G3 volumes;

(d) Development is then confirmed: Enables F2 → F1, giving E1, F1.3, G1. However, classification according to the G axis for E1, F1.3 and E1, F2.2 cases can be presented later in a future case study undertaken on more mature projects.

VII. Conclusions

54. The RF2013 to UNFC Bridging Document has been successfully applied to a case study for an onshore Russian oil field currently at the post-discovery, pre-development stage. C1 and C2 oil reserves reported under RF2013 have been classified under UNFC as the equivalent quantities of E3.2, F2.2, G1-G3 Resources. Some observations have been made regarding the requirement of additional information to classify C1 and C2 reserves along both the E and F axis and in mapping the G axis in this case study.